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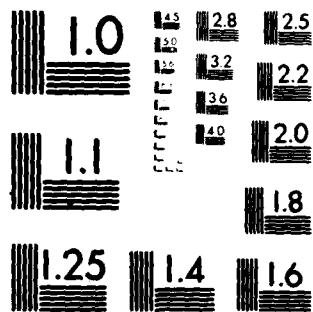
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# EXPOSURES

vol.9 no.5

a newsletter for ocean technologists

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## Test Results Of A Flotsam Shedder For The Grundy Model 9021 Current Meter

NOAA's National Ocean Survey uses the Grundy Model 9021 recording current meter (with rotor type speed sensor) in circulatory surveys of estuaries and rivers. In some instances the instrument is exposed to large amounts of trash and debris, i.e. flotsam, which have completely immobilized the rotor while deployed in the Hudson and East Rivers of New York. A flotsam shedder was designed and fabricated specifically for the Grundy Model 9021 current meter to prevent rotor fouling and the resulting loss of data. Pictured in Figure 1 with the current meter, and alone in the inset, the shedder is constructed from stainless steel with twenty 2.4 mm diameter spokes, 42 cm long, radiating 30 degrees from the horizontal axis of the current meter. When bolted to the 9021 rotor guards, the hub of the shedder is located approximately 28 cm directly in front of the rotor.

The following tests were conducted by the Engineering Support Office (ESO) to qualify the effects of the flotsam shedder on the current meter speed calibration and hydrodynamic stability.

### Test Apparatus

A steady flow calibration was conducted at the David Taylor-Naval Ship Research and Development Center (DT-NSRDC) Number 1 Tow Carriage Facility. A current meter, with a swivel-gimbal assembly, was attached to the tow carriage. The tow carriage speed was monitored by an HP 5328A Universal Counter taking period average measurements of pulses generated by a magnetic pickup; the pickup senses the teeth of a precision gear coupled to a tow carriage wheel. The Grundy rotor was monitored with an identical counter taking period measurements of pulses generated by an external photodiode sensor; this sensor was used to determine the time between the passing of two consecutive rotor blades.

November 1981

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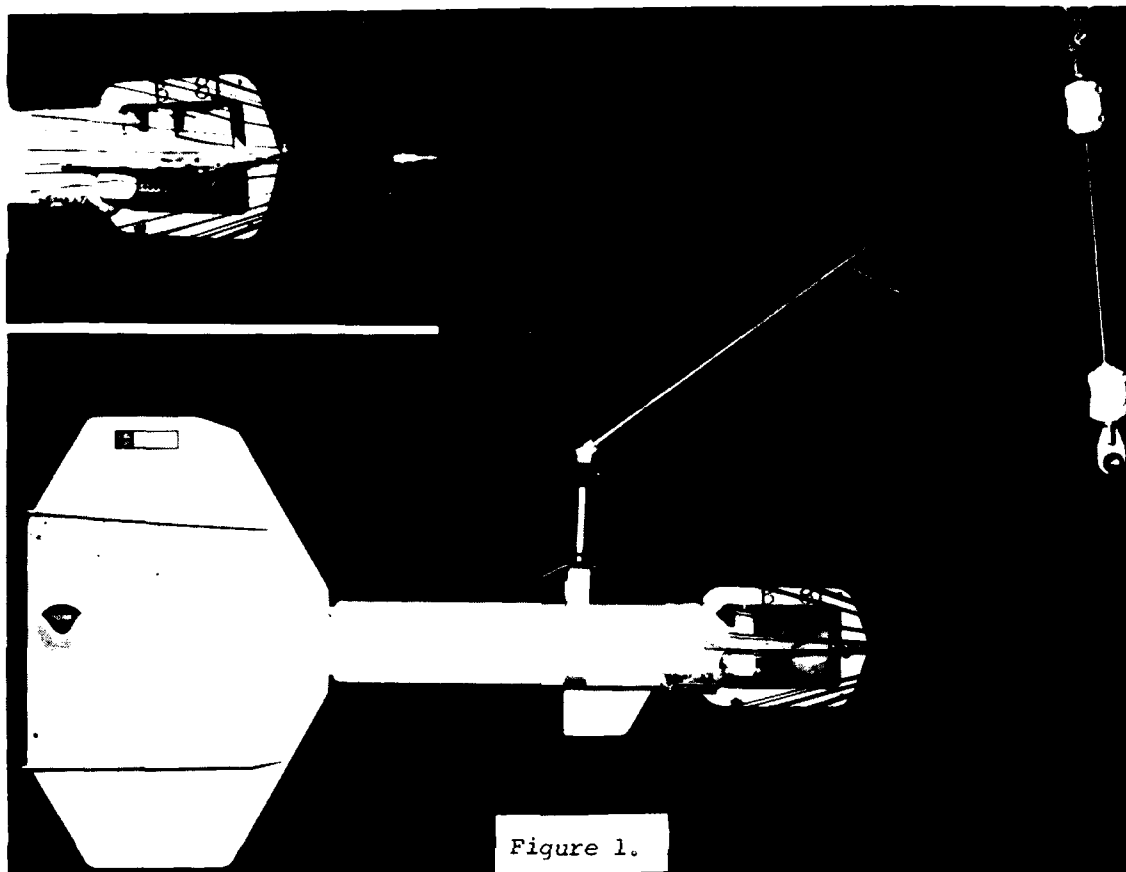


Figure 1.

An HP 9825T calculator was used to accumulate and process the measurements from both counters. The carriage and rotor measurements were converted to cm/s and r/min, respectively.

#### Rotor Calibration

The rotor r/min was converted to velocity using the following equation

$$V = 1.267 \times 10^{-5} N^2 + 5.412 \times 10^{-1} N + 1.046$$

where V is the indicated flow speed and N is the rotor rotation rate in r/min. Figure 2 displays the percent speed error of the rotor with and without the flotsam shedder as a function of tow carriage speed. The residual error is plotted as the percent difference between the

indicated flow speed and the true speed of the tow carriage. Each data point is determined from the average of 60 consecutive samples of rotor revolution and carriage speed. The results show a reduction of the rotor gain by approximately 4 percent due to hydrodynamic blockage caused by the flotsam shedder. The shedder also limits the speed measurements of the current meter to 250 cm/s. Flows above 250 cm/s cause the shedding rods to bend in towards the rotor stopping its rotation.

Tests indicated that the stability of the current meter under tow was not affected by the flotsam shedder. The 9021 pivoted smoothly and aligned itself without hesitation. There was no pitch or yaw observed during the test.

GRUNDY 9021 SN#81 ROTOR CALIBRATION  
NSRDC Carriage #1 7/1/81

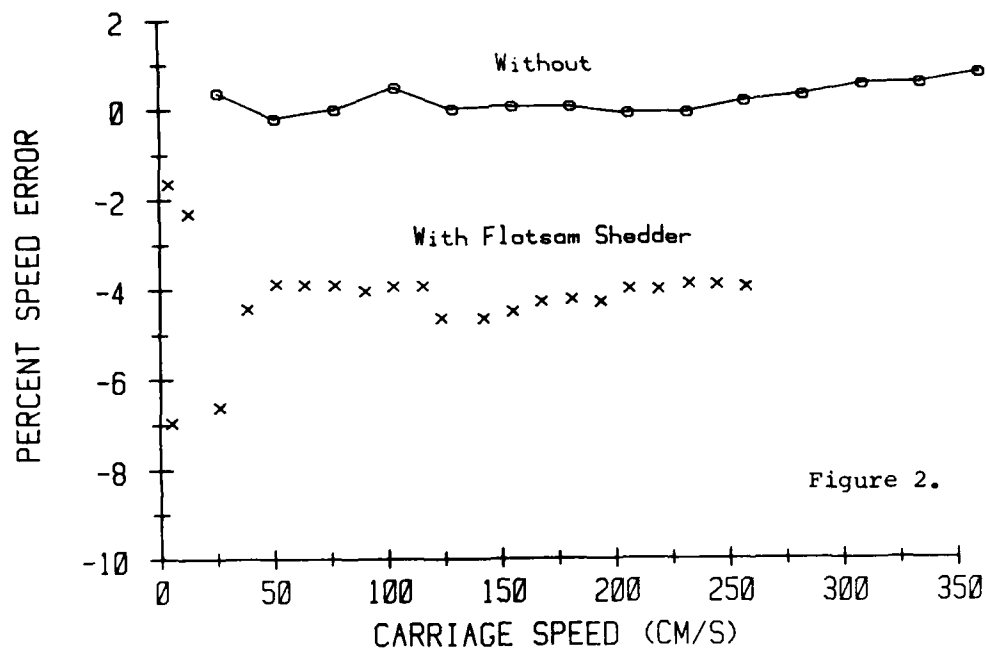
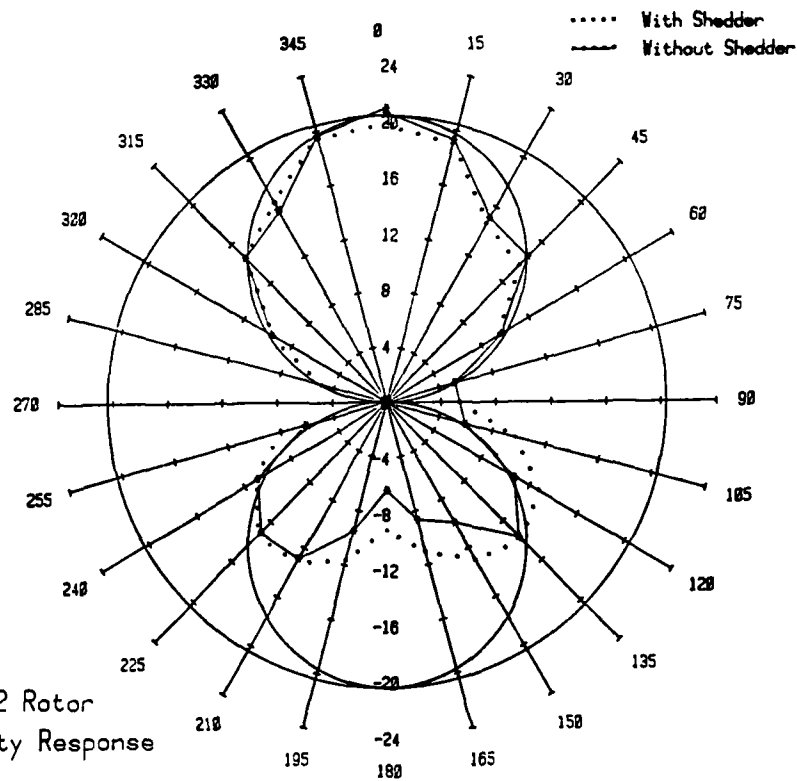


Figure 2.

Figure 3.



Plessey 9021 SN#52 Rotor  
Horizontal Directivity Response

### Horizontal Response To Steady Flow

Tests were conducted with the flotsam shedder and compared to previous data<sup>(1)</sup> taken without the shedder. The objective was to determine if the shedder would change the known horizontal cosine response of the rotor significantly to warrant further investigation.

Results displayed in polar form are seen in Figure 3. The outer circle represents the constant tow carriage speed; the inner two circles (seen as a figure eight) represent a perfect cosine relationship. The data collected with the shedder (the dotted line) is plotted next to the original data without the shedder (the solid line). Each data point represents the measured flow speed at the angle between the meter heading and the true flow heading. Good agreement exists between the two sets of data about the forward axis of the current meter, which is the critical area for accurate flow measurements<sup>(1)</sup>.

### Summary

The results of the steady flow tow tank show the flotsam shedder creates flow blockage which results in a four percent reduction in flow sensitivity of the rotor. In its present configuration, interference by the shedder rods limits the current meter speed range to 250 cm/s.

The current meter horizontal cosine response and stability is not significantly affected by the flotsam shedder. However, the current meter in-water balancing points are changed and should be re-established prior to deployment.

### Acknowledgment:

CDR John Callahan, the Commanding Officer of the NOAA Ship FERREL, was responsible for the design and

provided the initiative for the development of the flotsam shedder during the N.Y. Harbor Survey. Field tests conducted on the effectiveness of the flotsam shedder by CDR Callahan during the N.Y. Harbor survey were reported to be successful.

### REFERENCE:

(1) Frey, H. R., Appell, G. F., March 1981, "Measurements and Data Quality Assurance." NOS Strategic Petroleum Reserve Support Project: Final Report, Vol. 2, pp 34-40.

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# Continuous Shipboard Measurements Of Surface Salinity

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The Air-Sea Interaction Group of the School of Oceanography, Oregon State University, has recently constructed a portable system to measure and digitally record the temperature and conductivity of seawater pumped to the ship's laboratory from a subsurface intake. The construction was prompted by the need for a system to continuously measure and record surface salinity to an accuracy of  $0.01\text{‰}$ . Commercially available units were rejected because they were too expensive, did not have digital recording capability or did not have the desired accuracy.

The system consists of: 1) an oceanographic thermometer and conductivity meter manufactured by Sea-Bird Electronics; 2) SAIL (Serial ASCII Instrumentation Loop) counter modules<sup>(1)</sup>; 3) a microprocessor computer including an interface, CRT display, and cassette recorder; 4) a flow-through box housing the thermometer and conductivity meter; 5) a flow-through water filter; 6) power supplies; and 7) PVC plumbing. A schematic diagram of the system is shown in Figure 1 and a photograph is shown in Figure 2. Components, manufacturers, and costs are listed in Table 1.

The outputs of the thermometer and conductivity meter are 0.7 V rms sinewaves, the frequencies of which vary between 7 and 11 kHz as a function of temperature (0 to 25°C) or conductivity (2 to 5 siemens/m).

The SAIL counter modules were set to average frequency over a period of 10 s with a resolution of  $\pm 0.1$  Hz. The microprocessor computer is connected to the SAIL ASCII loop through an interface. The sampling rate, recording, and CRT display are controlled by software. The box housing the thermometer and conductivity meter was constructed of PVC plastic, 1/2-inch thick. The top of the box is removable and the outside dimensions are approximately 16x6x9 inches. The box has nine 3/4-inch PVC pipe fittings through which water can be circulated or conductors passed. A flow-through filter designed for drip irrigation systems is placed in advance of the input to the box. The filter contains a 0.1 mm mesh screen which can be cleaned. The box, filter, and associated plumbing are opaque to prevent the growth of marine organisms. It is important to note that additional sensors having either d.c. or frequency outputs can be recorded simultaneous to temperature and conductivity with additional SAIL modules. SAIL modules have also been designed for recording navigational information.

The absolute accuracies guaranteed by the manufacturer of the thermometer and conductivity meter are  $\pm 0.01^\circ\text{C}$  and  $\pm 0.001$  siemens  $\text{m}^{-1}$ , respectively, with typical accuracies one-third as large. These guaranteed accuracies correspond to an uncertainty in salinity of  $\pm 0.01\text{‰}$  at  $35\text{‰}$ .

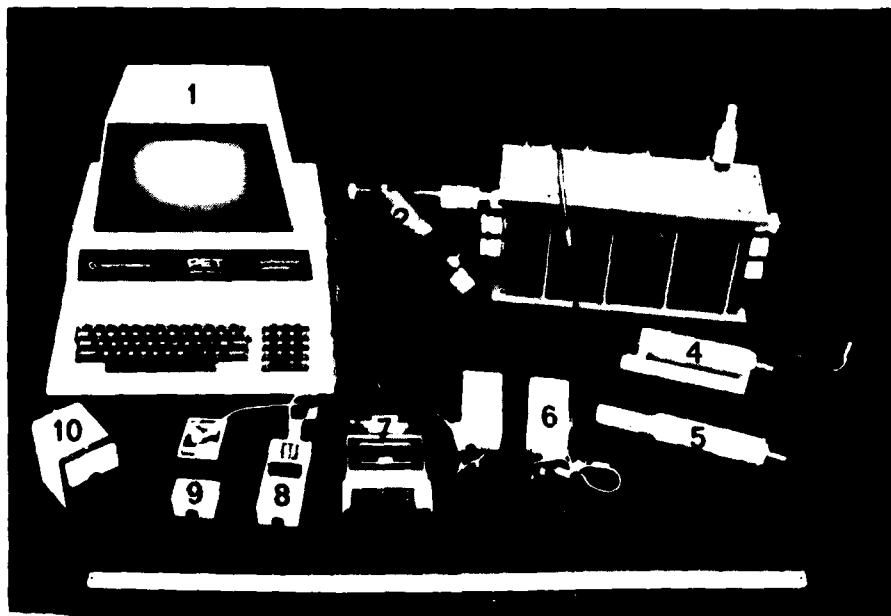
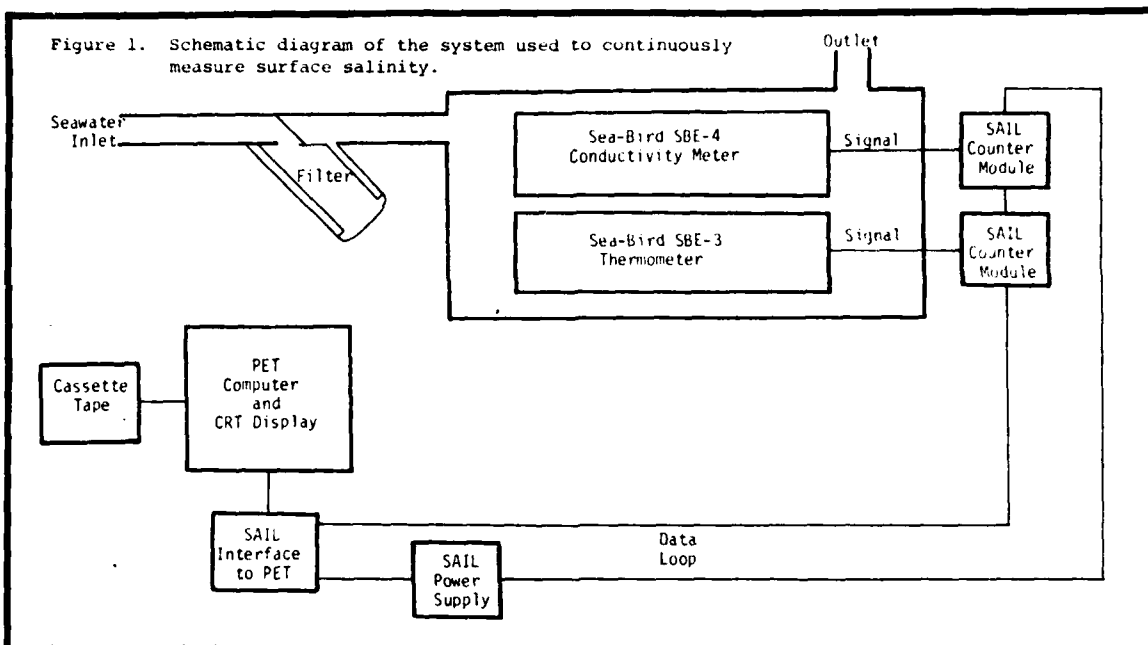


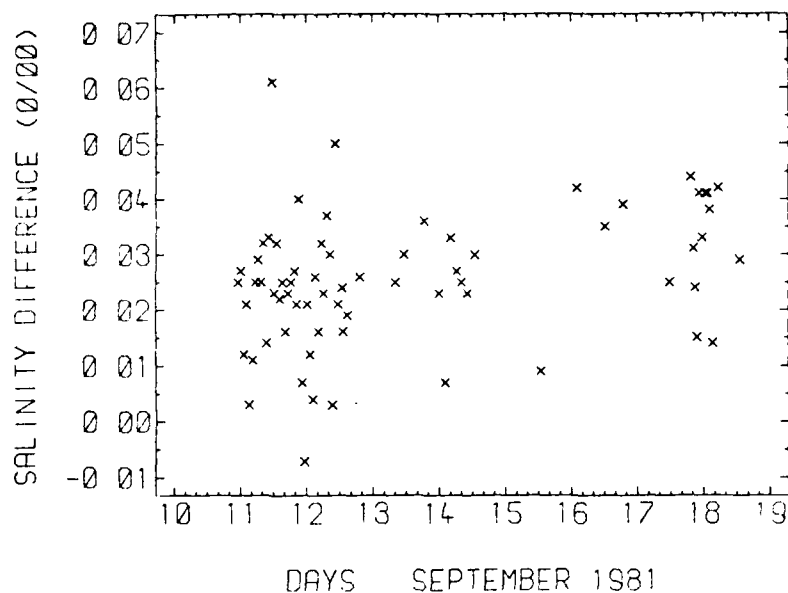
Figure 2. Photograph of components of the system used to measure surface salinity. The components are: 1) Pet computer; 2) filter; 3) box; 4) conductivity meter; 5) thermometer; 6) SAIL counter modules; 7) cassette recorder; 8) SAIL interface; 9) SAIL power supply; 10) instrument power supply.

The least count uncertainty of the recording system ( $\pm 0.1$  Hz) corresponds to uncertainties in temperature and salinity at  $15^\circ$  and  $35\text{‰}$  of  $\pm 0.0006^\circ\text{C}$  and  $\pm 0.0014\text{‰}$ , respectively.

The system was used at sea on the R/V OCEANUS during a cruise across the Gulf Stream in September 1981. The system ran continuously for 9 days at a digitizing rate of once per minute. During this period, 68



Figure 3. The difference in salinity (bottle sample minus continuous system) observed during a cruise across the Gulf Stream. The salinity varied between 32.81‰ and 36.29‰.



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water samples were taken which were subsequently analyzed for salinity. The difference between salinities from the water samples and salinities computed from the nearly simultaneous digital measurements of temperature and conductivity is shown in Figure 3. The mean difference is 0.025‰ with a standard deviation of 0.012‰. The systematic differences between the two independent sets of measurements can be ascribed to uncertainties in the absolute calibrations of the sensors and the recording system. The trend in the difference is consistent with the observed drift of the salinometer used to determine the salinities of the bottle samples. Random fluctuations of the salinity differences can be ascribed to least-count uncertainty, lack of simultaneity of bottle samples and in situ measurements, intermittent contamination of the conductivity cell, and possible degradation of

the bottle samples. The filter appeared to effectively remove biological contaminants from the seawater. If needed, additional filters could be added.

TABLE 1. Components, Manufacturers, and Costs (1/1/81)

Component	Manufacturer	Cost
1 Oceanographic thermometer, Model SBE-3	Sea-Bird Electronics, Mercer Island, WA	\$1000
1 Conductivity meter Model SBE-4	Sea-Bird Electronics, Mercer Island, WA	1400
2 SAIL counter modules	Technical Planning and Development Group, OSU	750
1 SAIL power supply	Technical Planning and Development Group, OSU	250
1 Interface	Technical Planning and Development Group, OSU	375
1 PET Computer, Model CBM2001-32N	Commodore	1400
1 Cassette recorder	Commodore	100
1 Flow-through bath	Technical Planning and Development Group, OSU	500
1 10-V Power supply for thermometer and conductivity meter	Acopian	100
Miscellaneous plumbing and connectors		100
Total		\$5975

The system appears capable of continuous digital measurements of surface salinity to an accuracy of  $\pm 0.01\text{‰}$  provided that bottle samples are occasionally taken to correct for systematic errors.

REFERENCE:

(1) Mesecar, R., "Serial ASCII Instrumentation Loop," EXPOSURE VII (4)



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